

Lateral Ridge Augmentation with Decalcified Cortical Bone Plate for Implant Site Preparation Resulting from Ridge Resorption

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ABSTRACT

Significant resorption of the lateral aspect of the ridge may occur following extraction of the teeth or related to resolution of pathology associated with the failing teeth which can hamper implant placement. Treatment of these lateral ridge deficiencies requires something to contain the graft to be placed as a tenting mechanism to achieve predictable increases in ridge width. Typically titanium mesh or blocks of cortical bone have been used for this purpose which both approaches have some negative issues in their use. This article will discuss the use of a decalcified flexible cortical bone plate that provides tenting for the graft and soft tissue while allowing adaption to the areas curvature and will become part of the new labial aspect of the ridge following graft healing.

Keywords: Cortical bone plate, Lateral grafting, Lateral ridge augmentation, Ridge width deficiency.

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INTRODUCTION

It is not uncommon that significant resorption may occur following extraction, which may be more prominent in the anterior maxilla due to the lower density of that are compared to the mandibular arch. How much resorption relates to a multitude of factors including; patients age, healing ability, medical health, and reason for extraction (perio, endo, trauma, or a combination of these). Additionally, bone maintenance relates to stimulation of the bone through function related to load transmission through the teeth (or implants). When that stimulation is removed through the extraction of the teeth, the surrounding bone resorbs (atrophies) with some patients demonstrating minimal bone loss while others will present with significant bone loss over time.

Bone loss occurs more significantly in the bone that is less dense than the bone that has a higher density. Therefore, the facial/buccal aspects of either arch will demonstrate more bone loss than the lingual/palatal aspects. The anterior maxilla (premaxilla) specifically in the area of the central and lateral incisors is more prone to bone loss following extraction. This relates to the lower density of the facial bone, typically the thinner bone over the facial aspect of the teeth with possible dehiscence's and fenestrations that naturally be present as well as the concavity in the vestibule related to the trajectory of bone present.

Resorption related to extraction or even periodontal disease over a period of time necessitating extraction may leave the area insufficient to house implants that are planned to replace the missing teeth. This will require an increase in the width of the ridge in the facial-palatal dimension to provide bone volume through osseous grafting and permit implant placement. Frequently this situation will require a two-stage approach with osseous grafting being performed, allowed to heal and mature, then later placement of the implants when the adequate bone volume is present to allow primary stability of the implants during their healing phase. The techniques to be described may also be used when there is sufficient ridge width crestally to place the implants but a

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fenestration presents at placement exposing a portion of the apical half of the implant.

CASE

A 52-year-old male patient presented missing the left central and lateral maxillary incisors with a desire to have implants to replace the missing teeth and a fixed prosthetic approach. The patient indicated that the teeth had been extracted 8 years before and clinical examination noted a deficient facial aspect of the ridge at the extraction sites and healthy soft tissue (Fig. 1). A cone-beam computed tomography (CBCT) was taken and evaluated. Cross-sectional views of the edentulous space confirmed inadequate width of the ridge in the facial-palatal dimension to house implants at the adjacent sites (Fig. 2). The patient was informed of the clinical findings and a discussion on augmenting the site with an osseous graft would be necessary for implant placement. As insufficient bone would not permit simultaneous implant placement at the

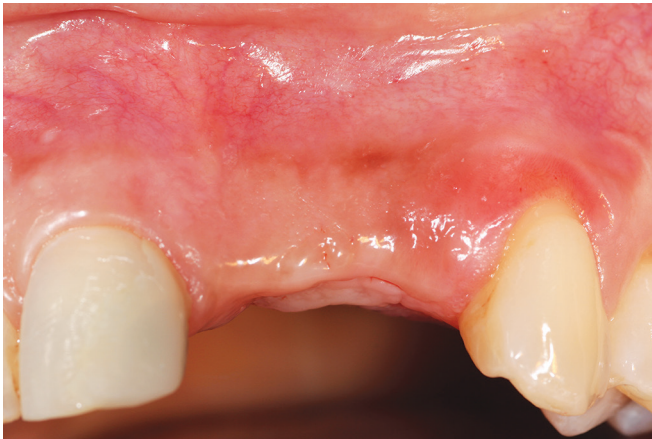


Fig. 1: Deficient facial aspect to the anterior maxilla resulting from resorption following tooth extraction

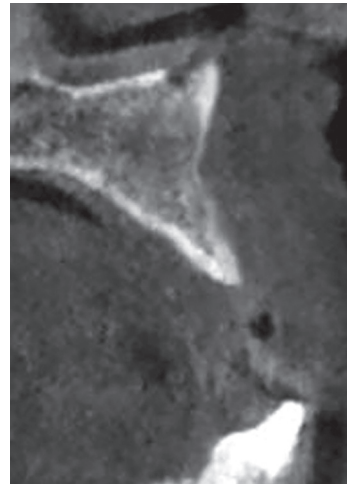


Fig. 2: CBCT cross-section demonstrating insufficient ridge width facial-palatally to permit implant placement in the healed extraction sites

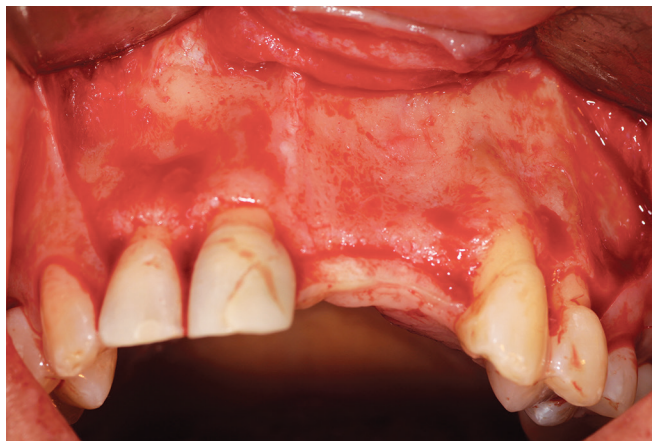


Fig. 3: A full-thickness flap was created to expose the deficient facial aspect of the edentulous premaxilla that will receive augmentation to accommodate implant placement



Fig. 4: The facial plate is fenestrated with a bur through the cortical bone in the edentulous space that will receive the osseous graft

time of grafting, the patient was informed that a healing period of 4–6 months would be needed between graft placements before implants could be placed. This would then be followed by a 4–6-months period to allow the implants to osseointegrate before any restoration could be placed on the implants. The patient agreed to treatment and was appointed.

The patient presented for phase 1 of treatment, ridge augmentation by lateral grafting. Following the review of the written consent, the consent form was signed by the patient. The blood was drawn from the patient's left antecubital fossa to fill four glass tubes (Becton, Dickinson and Company, Franklin Lakes, NJ) to be utilized to prepare the most current 2018 variations of the original platelet-rich plasma (PRP). Two tubes were placed into a PRP centrifuge (MedEquip Dental Supplies, Jupiter, FL) and spun for 3 minutes at 3,500 rpm. The short centrifuging time does not allow the blood in the tube to fully clot, but pre-clots the blood. While the blood was being centrifuged, a local anesthetic (4 carpules 4% Articaine with 1:100,000 epi (Dentsply Pharmaceutical, York, PA, USA)) was administered for local infiltration at the maxillary facial edentulous area and at the posterior buccal right, with addition to an IAN block in the lower right. Two tubes were placed in a separate centrifuge for 12 minutes at 1,500 rpm.

A #15 scalpel was utilized to create a vertical releasing incision between the right canine and lateral incisors and also between the

left first and second premolars. These were connected by a facial sulcular incision medial to the vertical releasing incisions and a midcrestal incision at the edentulous area. A full-thickness flap was elevated extending past the mucogingival junction to expose the deficient area as well as the bone covering the roots of the adjacent teeth (Fig. 3). A thin ridge with a notable concavity at the edentulous area was confirmed correlating with what was accessed on the CBCT exam. A three-sided 1.2 mm bur from MedEquip Dental Supplies in a surgical handpiece was utilized to create multiple decortication points through the cortical bone to the underlying cancellous bone (Fig. 4). This is performed to allow endosteal osteoblasts from the cancellous bone to interact with the graft, grow bone around and within the particulate graft particle, and to accelerate vascularization of the graft and incorporation to the osseous bed.

Next, the donor site would be addressed. A vertical releasing incision was created with a #15 scalpel blade between the right mandibular first molar and the second premolar (Fig. 5). A buccal sulcular incision was made on the first and second molars and continued as a crestal incision in the retomolar area buccal to the crestal midline and a full-thickness flap was elevated to expose the lateral aspect of the mandibular bone (Fig. 6). An mx-grafter (Maxilon, Hollis, NH) was utilized to scrape the exposed bone at the external oblique ridge to harvest the autogenous bone to be incorporated



Fig. 5: A vertical releasing incision is made between the first molar and the second premolar in the area to be flapped for donor site development in the right posterior mandible



Fig. 6: A crestal incision is made with a sulcular incision to connect to the vertical releasing incision that was created, and then a full-thickness flap is elevated to expose the lateral aspect of the mandibular body that will serve as the donor harvesting site



Fig. 7: Autogenous bone that was harvested with the mx-grafter (Maxilon, Hollis, NH) from the posterior lateral aspect of the mandible is placed into a sterile mixing dish

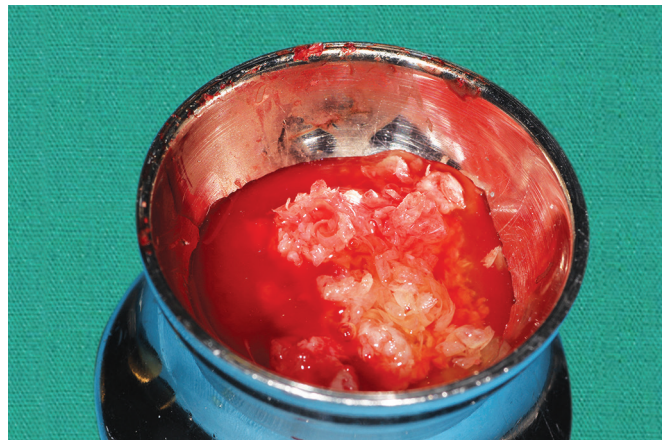


Fig. 8: Buffy coat from the PRP tubes that had been centrifuged is added to the sterile dish containing the harvested autogenous bone and particulate graft material

into the graft to be placed in the maxillary anterior. The harvested bone was placed into a sterile dish (Fig. 7). Cortico-cancellous 100–850 micron particle size and particulate graft material (Osteolife Biomedical) was added to the sterile dish to increase the volume of the grafts. The previously centrifuged blood taken at the beginning of the appointment had the buffy coat portion (middle layer) drawn from the tubes and placed into the sterile dish with the harvested autogenous bone and particulate graft (Fig. 8). Following stirring the mixture, it was allowed to sit for 10–15 minutes to allow completion of the clotting phase. The PRP buffy coat contains high levels of platelets that will act as a glue to hold the graft into a flexible mass and prevent displacement during initial healing. Additionally, the plasma has high levels of platelet-derived growth factors (PDGF-AB), transforming growth factor (TGF-beta1), and cytokines that can affect inflammation, angiogenesis, stem cell migration, and cell proliferation. The flap at the donor site was repositioned and closed with 4-0 interrupted PLA resorbable sutures (Violet, Osteolife Biomedical, Jupiter, FL) to achieve primary closure.

A 2-mm thick piece of Flexo-Plate Plus (Osteolife Biomedical) sized 15 mm × 30 mm was checked over the site to ensure adequate coverage of the defect and extension beyond its lateral borders (Fig. 9). The Flexo-Plate Plus is a bendable partially decalcified allograft with a thickness of 0.75–1.0 mm. The bone matrix

composing the Flexo-Plate is ultimately resorbed by the body eliminating the need for surgical removal of the matrix. This would serve to stabilize the graft to be placed into the facial defect and

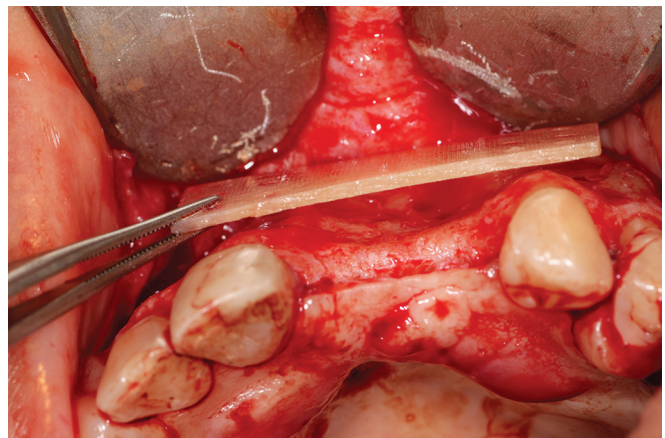


Fig. 9: A 15 mm × 30 mm piece of Flexo-Plate Plus (Osteolife Biomedical, Jupiter, FL) will be placed as the new facial extend of the ridge to contain the graft and act as a mold for the desired ridge augmentation

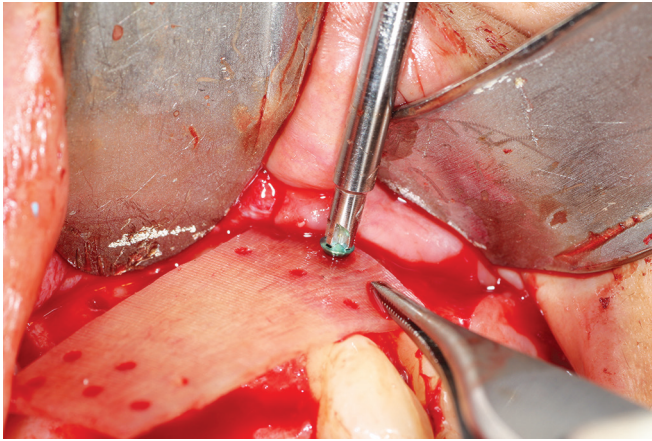


Fig. 10: Holes are placed through the Flexo-Plate Plus and fixation screws are placed to stabilize it on both the left and the right over the area being grafted

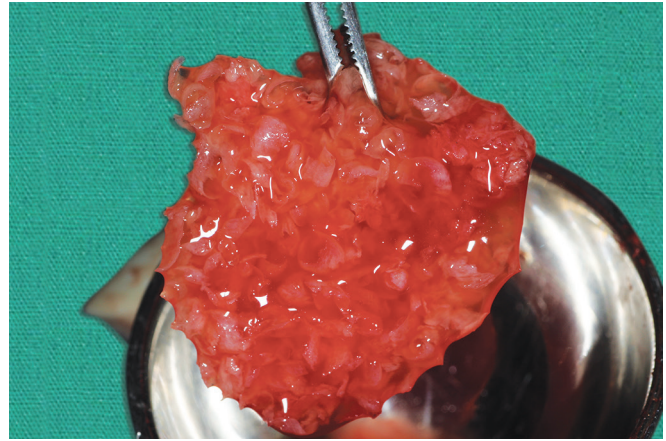


Fig. 11: The “gummy bone” graft material has coalesced into a flexible mass containing the PRP buffy coat, harvested autogenous bone, and particulate graft material

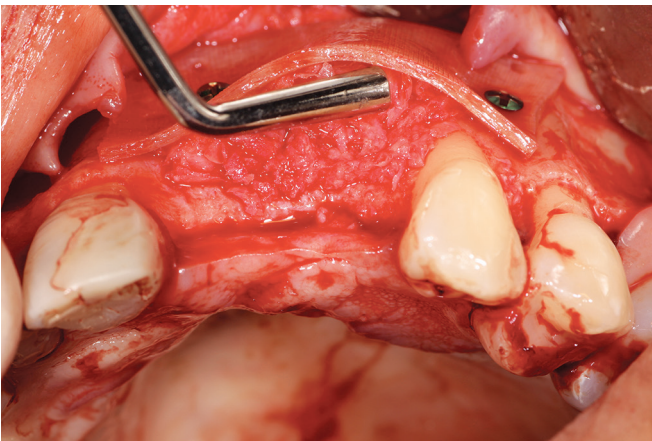


Fig. 12: The PRP autogenous and particulate graft (“gummy bone”) are placed into the space between the stabilized Flexo-Plate and the deficient edentulous ridge

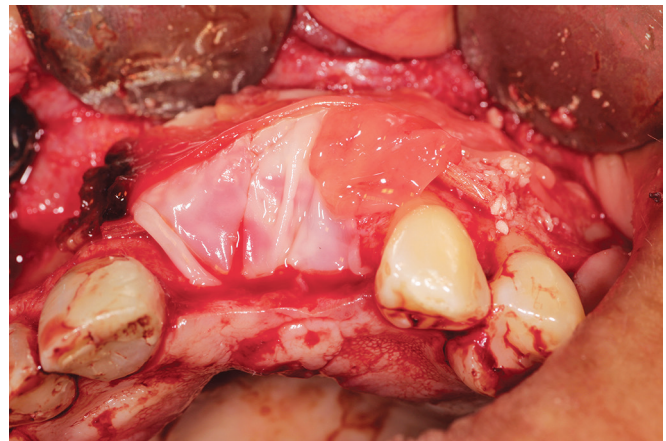


Fig. 13: A PRP membrane was placed over the grafted area prior to flap closure as a resorbable long-term membrane to prevent soft tissue ingrowth as the osseous graft heals and matures

upon healing become the new facial cortical plate. The plate comes predrilled with holes through the plate on the left and right aspects to accommodate fixation screws. The Flexo-Plate Plus was soaked in saline, to make it pliable and more easily adapted to the ridges' curvature. This was adapted to the arch and fixated with a single titanium screw on the left distal to the canine and on the right distal to the right central incisor (MedEquip Dental Supplies, Jupiter, FL) (Fig. 10). The graft mixture of PRP, autogenous bone shavings, and particulate graft had coalesced into a flexible mass in the sterile dish with the consistency of a gummy bear candy and is referred to as “gummy bone” (Fig. 11). This was carried intraorally and packed between the fenestrated facial plate and the stabilized Flexo-Plate to create what would be the new ridge width dimensions when healing had completed (Fig. 12). The graft and Flexo-Plate were covered with a PRP membrane (also referred to by some authors as PRF) which would act as a short-term barrier to prevent soft tissue ingrowth and a source of growth factors while the graft was healing and maturing (Fig. 13). The flap is reapproximated in a tension-free manner and the margins are fixated with 5-0 polypropylene sutures in an interrupted pattern (Fig. 14). Postoperative instructions were given and a booklet with instructions was provided to the patient.¹ These instructions included apply the ice bag over the affected area—20 minutes on, and 20 minutes off, for 2–4 hours, to help prevent the development of excessive swelling and discomfort,

avoid hot liquids and foods during the first 24 hours following surgery, and then warm salt water rinses 4–5 times daily for the next week. The patient was prescribed 24 tabs of Vicodin (5 mg hydrocodone bitartrate/30 mg acetaminophen) and instructed

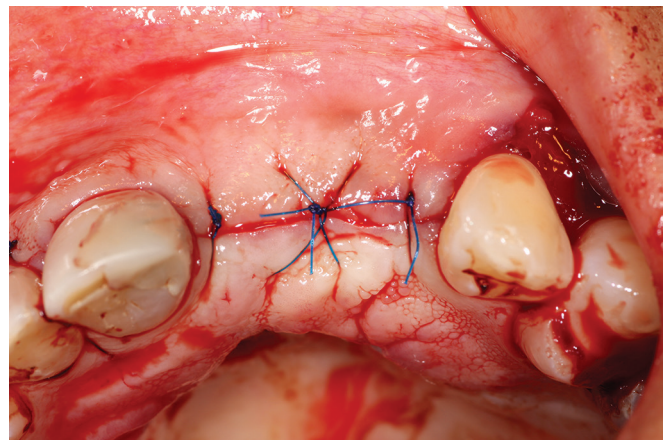


Fig. 14: Flap is closed without tension using 5-0 polypropylene suture (Riverpro, Osteolife Biomedical, Jupiter, FL) in a simple interrupted pattern

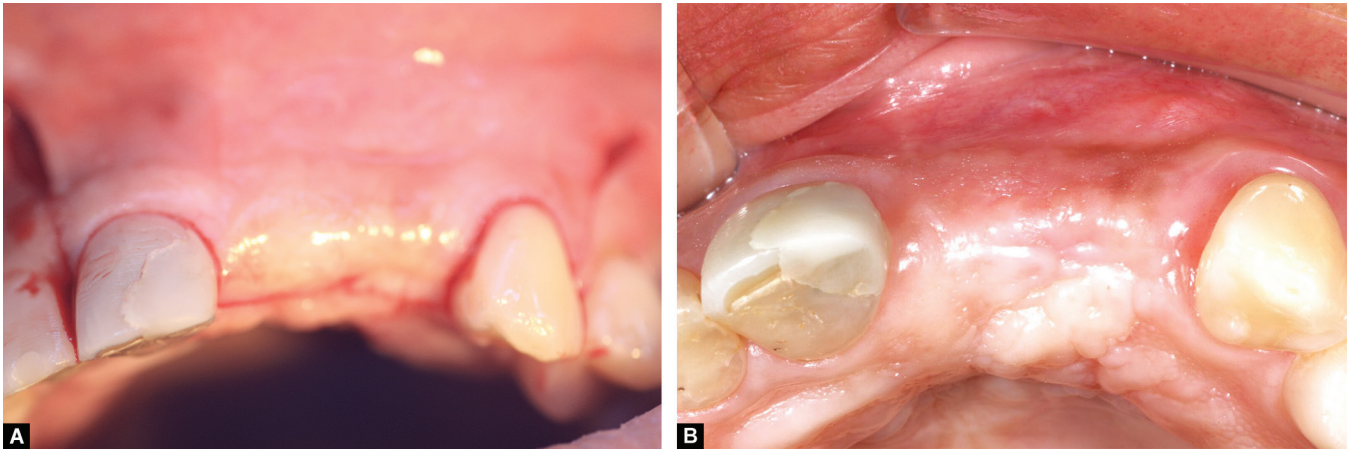


Fig. 15: The previously deficient ridge at the left central and lateral incisors resulting from resorption following the previously extracted teeth had been augmented and is ready for implant placement following 4.5 months of graft healing

to take 1 tablet every 6 hours for pain. A prescription for a Medrol Dose Pack was also given and the patient was instructed to take as the pack recommended.

The patient returned after 2 weeks for suture removal and site healing evaluation. Both the donor and recipient sites' flaps remained approximated and no gap was noted at the incisions and healing was progressing with an absence of inflammation. The patient reported that they were comfortable and were instructed to continue with warm salt water rinses for another week to aid in additional soft tissue healing.

At 4.5 months postsurgically, the patient returned and the soft tissue over and adjacent to the site demonstrated an absence of inflammation and appeared health with palpation of the grafted site feeling dense to the touch (Fig. 15). A CBCT was taken to evaluate graft maturation and alterations to the ridge width as a result of grafting. A CBCT cross-section of the graft revealed incorporation of the graft and dimensional changes to the ridge width that would now allow implant placement (Fig. 16). Local anesthetic (2% lidocaine with 1:100,000 epinephrine) was administered to the site via infiltration and a full-thickness flap was elevated. The graft was not discernable from the adjacent

non-grafted bone and appeared dense to instrument touch and the defect was filled resulting in adequate width for implant placement (Fig. 17). Osteotomies were created to accommodate a 3.7 mm × 13 mm implant (ImplantVision, West Palm Beach, FL) at the left central site and a 3.2 mm × 13 mm implant at the left lateral site and implants were placed and cover screws were attached (Fig. 18). The site was closed with 5-0 polypropylene sutures in an interrupted pattern and the patient was dismissed. Restoration of the implants would occur following a 3–5-months integration period. A CBCT taken following implant placement demonstrates the adequate thickness of the facial bone at the implant to house the implant and allow long-term stability (Fig. 19).

DISCUSSION

A frequent occurrence of loss of teeth in the anterior maxilla is loss of the facial plate creating osseous dimensions that will not accommodate implant placement. Resorption of the facial plate may present at the time of extraction when the tooth has undergone endodontic, periodontic, or structural (vertical root fracture) changes. This is often complicated by natural dehiscence's

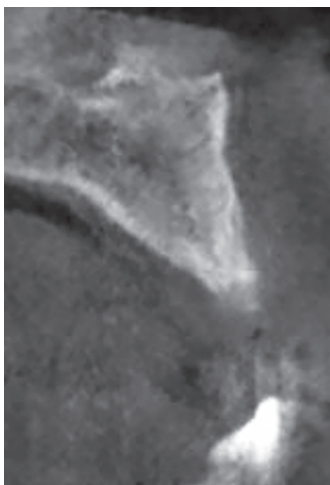


Fig. 16: CBCT cross section of the grafted facial aspect of the deficient ridge demonstrates adequate width for implant placement following healing of the graft at 4.5 months



Fig. 17: The healed grafted ridge at 4.5 months following flap elevation demonstrating adequate width facial-palatally to allow implant placement

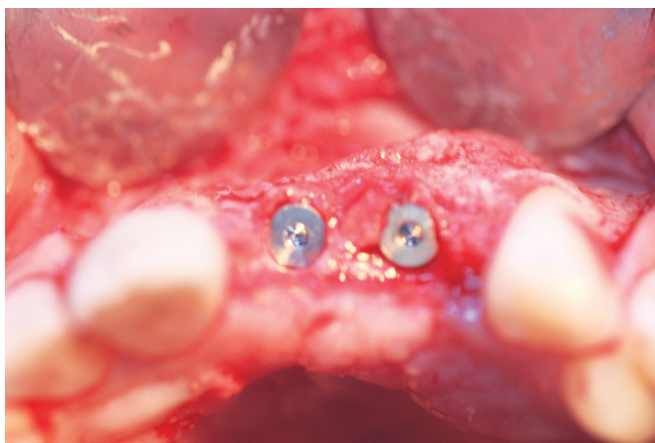


Fig. 18: Implants have been placed into the grafted previously deficient ridge showing adequate bone to house the implants and a lack of dehiscence on the facial aspect, shown prior to flap closure

and fenestration's found on healthy teeth that worsen when pathology arises.

Reconstruction of the deficient premaxilla has been proposed with multiple treatment options. These have included the use of cortical blocks retrieved from another site (ramus and iliac crest) and fixated with screws during healing. Titanium mesh has been proposed to cage graft material allowing the ridge to be rebuilt. Ridge splitting has been another treatment advocated to create a ridge that could accommodate implant placement. These approaches have negatives to their use. Cortical blocks require a donor site which increases morbidity and decreases patient comfort during the healing phase. Additionally, should the block not integrate with the recipient bed, separation may result either at the time of implant placement or when under restorative function. Some healing resorption has been reported and overbuilding the site may be considered to accommodate that loss of volume during healing.² Utilization of titanium mesh requires a second surgery to remove the metal mesh and screws which is performed when implants are ready to be placed into the healed site. But, the main reported complication to use is premature exposure of the mesh.³ This may necessitate early removal of the mesh decreasing the quality and quantity of bone resulting from the graft that was caged by the mesh.⁴ Implant success in areas utilizing titanium mesh to contain grafting does show a high success rate even with the complications typically encountered during the healing phase.⁵

Ridge splitting has been advocated to treat the narrow ridge but a minimum width of the ridge is needed to be able to effectively split it. Resorption occurs in the vertical dimension at the expense of the less dense facial plate. When splitting the ridge, due to the density of the palatal bone, expansion occurs in the facial direction. If the ridge has lost a significant facial osseous structure, expansion cannot be achieved. Minor complications have been reported to ridge splitting when adequate initial ridge width was present that included wound dehiscence and fracture of the facial plate due to a bad split. But complications were at an equal incidence to block grafted sites.⁶

The technique illustrated in the case presented here is an alternative method that eliminates the need for cortical bone from a donor site and decreases the complications reported with the use of titanium mesh to contain the graft. Additionally, the width of the residual ridge does not determine if this technique may be used as limits ridge splitting. As cortical fragments are taken from the patient with the bone scrapper and mixed with PRP derived from the patients



Fig. 19: CBCT cross section following implant placement demonstrating adequate width to house the implant and sufficient facial plate thickness

own blood, the potential for foreign body reactions is minimized. Stem cells from the patient are able to "kick start" the healing and conversion to the bone that has high enough quality to accommodate implant placement after graft healing. Ideally, implants should be placed into the medullary bone in contact with the majority of its surface as this bone is dynamic and active. The cortical bone is denser but lacks osteoblasts and other bone maintaining cells which may demonstrate the radiographic dense bone on contact with the implant but not be able to respond to changes related to function on the implant as well. Utilization of the flexible bone plate (Flexo-plate plus) from the supplier eliminates the need for titanium mesh to contain the graft and, like a cortical block, becomes part of the healed graft. The added benefit of this technique over cortical blocks is the resulting bone for implant placement that has a medullary quality and implant placement into it has active bone progenitor cells in contact with the implants' surface. The risk of exposure of the bone plate, unlike titanium mesh, is eliminated as the body does not identify the bone plate as foreign. The overlaying PRP membranes stimulate soft tissue healing and the stem cells within penetrate into the bone plate using it as a scaffold to convert it to host bone over time. The gummy bone being sandwiched between the Flexo-plate plus and the recipient bed has the added advantage over particulates even when wetted by saline or blood at the site of being moldable like a putty, while not being displaceable as often observed with particulates.

CONCLUSION

Reconstruction of the atrophic maxilla to accommodate implant placement can be challenging. Various techniques have been reported to rebuild the deficient area. The technique described here eliminates some of the potential complications associated with other reported techniques and provides a high-quality bone that is suitable for implant placement.

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